SPECIAL REPORT

BENEFICIATION OF SAMPLES OF GEORGIA QUARTZITE

Project E-100-570
Minerals Beneficiation Research

by

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
PURPOSE	1
SUMMARY OF RESULTS	1
RECOMMENDATIONS	2
PRELIMINARY EXAMINATION	3
RUN-OF-MILL EXAMINATION	5
Screening	6
Beneficiation	6
Discussion of Results	11
APPENDIX I. DETAILS OF PROCESSING PROCEDURES	12

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INTRODUCTION

A sample of quartzite (silica sand) from a deposit in Pike County, Georgia, was brought to the State Department of Mines, Mining and Geology for preliminary evaluation and advice as to the economic feasibility of commercial utilization. Microscopic examination indicated a high quality sand containing some mica and clay, and merited evaluation efforts.

Consistent with the close liaison established between the Department and Georgia Tech in the South Georgia Minerals Program, it was agreed that the Department would obtain samples and carry out petrographic microscope examinations and chemical analyses, and Georgia Tech's laboratories would investigate techniques for separating in-situ material into the various products.

PURPOSE

The purpose of this report is to present the data obtained for a determination of the technical feasibility of beneficiating samples of the deposit into separate end products.

SUMMARY OF RESULTS

It is technically feasible to produce a high quality sand product in the -30+325 mesh range from the ore by a straightforward flotation process preceded by either crushing or simple scrubbing-screening, depending upon the particular ore.

The sands product may be divided into size fractions, such as -30+150 and -150+325 mesh as desired to meet customer's requirements.

Particularly from Sample S-2, recoverable by-products of clay (kaolin), mica, and fine garnet, may be economically feasible. Sufficient work has not been done to make this a definite statement.

RECOMMENDATIONS

It is emphasized that this report presents data from but four samples; two samples taken at 34 and 50 feet below the surface in two holes respectively, and two from apparently close proximity to each other at 7.5 and 8.0 feet from the surface respectively. Yet these latter two samples were distinctly different; one apparently suitable for recovery of a glass quality sand product only, while the other had potential for a similar grade sand product and mica, kaolin, and fine garnet by-products.

It is further emphasized that manufacturers utilizing these products require close control of quality of the material to insure a consistently uniform supply. No attempt has been made by Georgia Tech to determine the quantity and uniformity of the deposits.

With these precautionary observations, it is recommended that:

1. Additional samples, truly representative of the ores to be mined, be investigated to determine uniformity.

2. The technical and economic feasibility of recovering useful by-products--clays, mica, and fine garnet--be determined through further work.

3. Further work on this deposit should be accomplished through establishment of a normal research and development project with costs borne by the sponsor.

PRELIMINARY EXAMINATION

The first sample had indicated a material of exceptionally high interest. It was deemed advisable to obtain larger samples, representative of the ore body, for preliminary examination prior to more complete investigations.

A number of holes were auger-drilled by the Department of Mines, Mining and Geology and two samples, selected as being representative of the ore body, were brought to Georgia Tech for study. One was a sample from Hole No. 7 at a depth beneath the surface of 50 feet. The second sample was from Hole No. 9 at a depth of 34 feet. These samples were combined and screened through Tyler sieves to produce products in the particle size ranges of interest to industry:

Through 35 on 150 mesh

Through 150 on 325 mesh

Through 35 on 325 mesh

Part of the first two size ranges were simply washed to remove clays (usually finer than 325 mesh) and any soluble material, and the washed product analyzed. For a higher quality sand product, impurities, such as mica, may be removed by a process called "flotation" which has been employed by industry for years. Accordingly, all three size ranges of particles were washed and then beneficiated by flotation and the products analyzed. Only iron, aluminum, and "Loss on Ignition" (LOI), which is a measure of the presence of hydrates and readily decomposable material, were determined. These were thought to be the key impurities which would permit an evaluation of whether the silica sand had a potential for use in glass manufacture. The results are given in Table I. The slightly

TABLE I

CHEMICAL ANALYSES OF BENEFICIATED QUARTZITE

Particle Size Range, (Tyler) Mesh	Sample	Iron Oxide % Fe_2O_3	Aluminum Oxide % Al_2O_3	Loss on Ignition %
-35+150	Washed Only	0.05	1.20	0.21
-150+325		0.08	3.50	0.92
-35+150	Washed and Floated Tailings	0.02	0.30	0.10
-150+325		0.03	0.40	0.10
-35+325		0.03	0.40	0.10

lower quality of the fractions containing particles finer than 150 mesh is probably due to the presence of fine garnet as detected by petrographic analysis by the Department of Mines, Mining and Geology.

The data show the benefit of flotation through enhanced quality of products and indicate that the sand tailings from flotation have definite potential for manufacture of high grade glass. For evaluation, these data must be compared with specifications of glass sands. Chemical specifications vary from company to company, and it is considered that uniformity of composition of the sand is as, or more, important than minor variations in the amounts of iron and aluminum.

Specifications for sands are given and discussed in Appendix I, Project Report No. 6 (May 1967) of the South Georgia Minerals Program. For the purposes of this report, pertinent data may be abbreviated and summarized as shown in Table II.

It is seen that the products of flotation from the composite of the two samples apparently would meet the specification of two of the three companies and "Second Quality" suggested by the American Ceramic Society, and almost "First Quality."

TABLE II

CHEMICAL SPECIFICATIONS (PARTIAL LIST)
FOR GLASS QUALITY SAND

Source	SiO_2 Min. %	Fe_2O_3 Max. %	Al_2O_3 Max. %	LOI Max. %
1. Suggested for adoption by American Ceramic Society				
First Quality: Optical Glass	99.8	0.02	0.1	
Second Quality: Flint, Tableware	98.5	0.035	0.5	
2. Company "A"	99.88	0.19	0.12	0.08
3. Company "B"	Balance	0.025	0.5	-
4. Company "C"	99.3	0.03(1) 0.15(2)	(3)	-

(1) = For crystal glass
(2) = For colored glass
(3) = As low as possible and controllable

RUN-OF-MILL INVESTIGATION

The results from the preliminary sample were so favorable it was decided to repeat and extend the investigations on samples which would be representative of the body of the deposit. By extension of the investigation is meant crushing, particle size distribution analysis, and determining the feasibility of recovering by-products of commercial value--primarily mica and finely-divided, good quality silica. The Fiber-Glass people have stated a preference for fine sand--99.5% through 200 mesh and 95.5% through 325 mesh screens (reference: "The High Silica Resources of Tennessee," R. E. Hershey, Tennessee Division of Geology, Report of Investigation No. 10, 1960).

Two samples were received. It is understood that these samples were obtained at Conkel Farm at 7.5 feet (Sample S-1) and from 8.0 feet

(Sample S-2) after a bulldozer had removed the overburden. S-1 consisted of chunks of white "rock"; S-2 of fine white "sand." It is further understood that S-1 was representative of sands deposits and S-2 representative of deposits containing mica and of a greater part of the overall deposits. The position relationships of these "near surface" deposits to the preliminary samples at 50 and 34 feet below the surface are not known to Georgia Tech.

Screening

Sample S-1 was ground in a Hammermill having a screen with 0.25 inch holes. It crushed readily. Sample S-2 was already in divided "sands" state, did not require crushing, and the agglomerates divided readily during the scrubbing-screening process. The products, on screening, were analyzed for particle size distribution. It is interesting to note that the moisture content for S-1 is 1.0% and for S-2 is 3.5%, indicating considerable difference in the two samples.

It is noted that both samples have excess amounts of fine particles, which should be removed to meet glass sand specifications. Also, that Sample S-2, purportedly more representative of the bulk of the deposits and containing more mica, has a finer particle size distribution.

Accordingly, Sample S-1 was considered as having potential for "glass-sands" use; and S-2 for "glass-sands," fiber-glass, and mica.

Beneficiation

Samples of S-1 and S-2 were ground, wet screened, and the -35+325 mesh material used as a feed for flotation treatment. Due to the larger amounts of mica in Sample S-2, the mica concentrates were "cleaned" twice.

TABLE III

MOISTURE AND SCREEN ANALYSES

Sample	S-1	S-2
Moisture Content, % H_2O	1.0	3.5

Screen Analysis

Sample	S-1		S-2		
	Weight %	Cumulative Weight %	Weight %	Cumulative Weight %	Spec. of Amer. Cer. Soc. for Glass-Sand
Retained on U.S. Standard Screen Mesh No.					
20	1.8	1.8	2.5	2.5	0.0
30	4.5	6.3	1.7	4.2	
40	8.5	14.8	2.1	6.3	40-60
50	13.3	28.1	2.5	8.8	
60	-	-	-	-	30-40
70	19.3	47.4	6.7	15.5	
100	17.7	65.1	20.2	35.7	10-20
140	14.5	79.6	19.9	55.6	
200	7.5	87.1	11.7	67.3	
325	7.6	94.7	21.7	89.0	
Thru 325	5.3	100.0	11.0	100.0	Thru 100: 0-5

For each sample, the amount of flotation reagents used were:

Amine S-1506	0.5 lb/ton dry solids
Diesel Oil (Sp. Gr. = 0.875)	0.5
Pine Oil	0.1
Hydrofluoric acid (50%)	0.125
Sulphuric acid (98%)	2.0

Details of the procedure followed with each sample are given in Appendix I.

Sample S-1

Data obtained from wet screening and flotation of this sample are given in Table IV.

TABLE IV

SCREEN AND FLOTATION PRODUCTS RECOVERY

Sample S-1

	Particle Size Mesh	Weight %	Product Fe_2O_3 %	Impurities LOI %
Wet Screening Products				
Oversize	+30	7.0		
For Flotation Feed	-30+325	88.9		
Clays	-325	0.2		
Non-Clays Fines	-325	3.9		
Total		100.0		
Flotation				
Feed		100.0		
"Rougher" Tailings(1)		94.5	0.02	0.09
"Cleaner" Tailings		3.9		
Mica Concentrates		1.6(2)		

(1) 4.9% of these tailings had magnetic characteristics and were removed by a magnetic roll separator, giving an exceptionally clean, non-magnetic product. However, it analyzed 0.02% Fe_2O_3 and 0.08% LOI so but little was gained by this step.

(2) This mica product was of apparent poor quality.

APPENDIX I

DETAILS OF PROCESSING PROCEDURES

Sample S-1

1. Sample was broken with a hammer and the 3 to 4 inch chunks were fed (moist) to a Williams Hammermill with a 0.25 inch hole screen.

2. The ground sample was mixed and 3 samples taken: one for storage, and two samples for moisture and screen analyses.

3. The rest of the sample was wet screened through a 30 U. S. mesh screen. The +30 mesh was dried and re-screened, dried and weighed. The -30 mesh was added to the wet -30 mesh portion. The wet -30 mesh was then screened thru a 325 mesh.

4. The 30 X 325 mesh cut was wet stored for further flotation work.

5. The -325 mesh cut, with most of the water, was treated with tetra-sodium pyrophosphate to disperse the clay minerals.

6. After 24 hours, the clay fraction of the -325 mesh was syphoned off from the vessel, and the -325 mesh non-clay fraction scraped from the bottom of the vessel and dried.

7. The clays were treated with Superfloc 20 (a flocculant) dewatered, and dried.

8. Flotation

Wet sands in the 30 X 325 mesh size cut were weighed wet in 1250 gm charges which were approximately equal to 1000 gm dry.

Each charge was conditioned and floated with the flotation parameters shown in Table AI-1. The amine, diesel oil and hydrofluoric acid were added together as an emulsion. The mica concentrate was cleaned once and the products dried.

9. The products of four charges were individually mixed and weighed.

10. A sample was cut of the dry rougher tailings and passed through the high intensity magnetic separator, to test the possibility of reducing the iron content of the sand. Chemical analyses of the rougher tailings and of the non-magnetic portion of the tailings were made.

Sample S-2

1. The sample was mixed and three samples taken; two samples for moisture and screen analyses and one for storage.

2. The sample was wet screened through a 30 mesh screen. The +30 mesh was dried.

3. The presence of white, opaque grains in the -30 mesh cut made it necessary to scrub this material before screening thru the 325 mesh screen. 1000 gram batches were scrubbed at 1200 RPM for 10 minutes in a Denver Laboratory Scrubber.

4. After scrubbing, the -30 mesh was screened wet through a 325 mesh. The +325 mesh kept for flotation testing and the -325 slurried with water, dispersed with tetrasodium pyrophosphate and allowed to settle for 24 hours.

5. Then, the clay minerals were decanted, flocculated with Superfloc 20, and dried.

6. The -325 (non-clay) was likewise dried.

7. Flotation

The procedure used on this sample was essentially the same as followed for sample S-1, with the exception of cleaning the mica concentrate twice.

8. The products of three charges were individually mixed and weighed.

9. Magnetic separation of the rougher tailings showed no separation of magnetic minerals.

TABLE AI-1

FLOTATION PARAMETERS

Dry Weight of Charge: 1000 g.

Conditioning

Machine: Lightning Mixer

RPM : 500

% Solids: Approx. 50

Reagents	lb/ton Dry Solids
Amine S-1506	0.5
Diesel Oil, Sp. Gr. 0.875	0.5
Pine Oil	0.1
Hydrofluoric Acid (50%)	0.125
Sulphuric Acid (98%)	2.0

Addition: 1 lb. Sulphuric Acid, 5 seconds; Emulsion, 25 seconds; 1 lb. Sulphuric Acid, 30 seconds. Total condition time: 1 min.

Flotation

Rougher Flotation: Denver D-1 machine, 1200 RPM, 1000 g. tank.

Time: 1 minute

Cleaner flotation: Denver D-1 machine, 1000 RPM, 500 g. tank. 0.5 lb. Sulphuric Acid added on cleaner. Time: 1.5 minutes.